Health Impacts of the COVID-19 Vaccination and Testing Emergency Temporary Standard (ETS)

A. Introduction

In this analysis, OSHA is examining the number of fatalities and hospitalizations averted due to OSHA's estimate of the number of employees who will be vaccinated because of the COVID-19 Vaccination and Testing Emergency Temporary Standard (ETS), 29 CFR § 1910.501, under a variety of scenarios.[1] OSHA's main analysis, as discussed in more detail below, is based on the actual number of cases and fatalities reported to the CDC during the pandemic from the week of April 4, 2021 through the week of August 29, 2021 (5 months of recent data). From this foundation, OSHA estimates the number of worker hospitalizations and fatalities that will be averted while the ETS will remain in effect.[2] Throughout its main analysis, OSHA has sought to make assumptions that will likely have the impact of under-counting the fatalities and hospitalizations averted; OSHA also provides several sensitivity analyses in which OSHA examines potential outcomes by varying several of the key economic assumptions or estimates from those in the main analysis.

Table 1, below, provides a summary of the number of hospitalizations and fatalities that OSHA estimates will be avoided due to increased vaccinations caused by the ETS for workers ages 18-64 (OSHA's main estimate), as well as estimates expanding the number of workers to include ages 18-74 (OSHA's alternative scenario). OSHA explains how it derived these estimates, as well as its rationale for not including workers over the age of 64 in its main estimate, later in this analysis.

Table 1. Main Estimate and One Alternative Scenario

Scenario	Hospitalizations	Fatalities
Main Estimate (Age 18-64)	277,736	6,830
Alternative Scenario A (Age 18–74)	563,102	13,847

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[1] OSHA's Health Impacts analysis is different, and more limited than, the benefits portion of a regulatory impact analysis prepared in accordance with Executive Order (EO) 12866. Further differences (relative to this rulemaking package) include society-wide cost assessment being part of an EO 12866 regulatory impact analysis, as well as consistency across benefit and cost assessments, which is necessary for the cost-benefit analysis provided for in that Executive Order. Relatedly, EO 12866 analysis compares the projected future with and without a regulation, attributing differences (costs, benefits or other effects) to the regulation, regardless of whether they are directly mandated.

[2] Solely for purposes of preparing this impact analysis, OSHA assumes the ETS will remain in effect for 6 months.

Health Impacts Not Quantified

There are certainly other positive impacts of this ETS to workers. While OSHA did not quantify these impacts, they are nonetheless significant. OSHA notes that many of the impacts discussed below can be quantified; OSHA did not do so here because the emergency conditions created by the pandemic necessitated a simpler, yet still robust, quantified analysis that nonetheless provides evidence of the substantial impact this ETS will have on worker health. This results in a Health Impacts quantified analysis that is significantly biased towards the lower bound, and results in an underestimate of the true Health Impacts of the ETS.

In any event, although not quantified, OSHA notes that the increased vaccination of workers resulting from the ETS will reduce the risk of infection, hospitalization, and death, not only in workers who become vaccinated under the ETS, but also in those workers who remain unvaccinated under the ETS – because vaccinated workers are less likely to spread the virus to unvaccinated workers. In addition, averting COVID-19 related infections that do not result in hospitalization or death will also support effective functioning of the economy (e.g., through reduced absenteeism, see Section IIIA of the Economic Analysis). Moreover, OSHA does not quantify the positive impacts of the ancillary protections required by the standard for those employees who do not get vaccinated under the rule (i.e., testing and masking of workers), although, as noted in other sections of this preamble, those ancillary measures are needed to address the grave danger the remaining unvaccinated workers are facing. OSHA also does not quantify other impacts of both vaccination and the ETS's ancillary provisions, such as the reduction in breakthrough cases for vaccinated workers who, in the absence of the ETS, could be exposed to a greater number of potentially infectious unvaccinated and unmasked workers or COVID-19 positive workers not removed in accordance with this standard. This analysis also does not quantify reductions in long haul COVID and unhospitalized illness, even when temporarily incapacitating, for workers.

OSHA notes that the agency's impacts analysis also does not quantify the positive impacts the ETS will have, not only on workers, who will be directly impacted by the rule and who are within OSHA's authority to regulate, but also on the broader economy and society as a whole. For example, the agency excludes in its main Health Impacts analysis the positive impacts that vaccinating workers will have in reducing their COVID-19 infections, hospitalizations, and fatalities from infections caused by non-workplace exposures, or community acquired infections (although these are quantified as ancillary impacts in Table 2). The agency also does not quantify the secondary health impacts of avoided COVID–19 cases among family and friends that would occur due to exposure to an infected worker absent the ETS, nor does the agency quantify the huge strain on families of sick workers that will be alleviated by the ETS. The agency also does not quantify the health impacts of avoided cases that would otherwise occur due to workplace transmission from employees to clients or other visitors. In addition, the agency does not quantify the impacts associated with the fact that patients hospitalized for COVID–19 require substantial health care resources such as staff, beds, and equipment, and that the reduction in infections, hospitalizations, and fatalities because of the ETS will increase resources available to treat patients with both COVID–19 and non-COVID–19 ailments. Many hospitals have been at or near intensive care unit (ICU) capacity due to the surges in COVID–19 cases during the pandemic, diminishing the health care system's ability to provide essential

healthcare services (Dutton and Mosely-Morris, September 16, 2021). Finally, the agency does not quantify the non-health related positive impacts to underserved communities that have disproportionately experienced loss of life and jobs throughout the pandemic, or other positive economic impacts that will accrue because of the reduction in infections, fatalities, and hospitalizations owing to the ETS.

To ensure its main analysis tends toward the lower bound (thereby avoiding over counting hospitalizations and fatalities attributed to this ETS, including health impacts that may be attributed to other federal mandates), as discussed further below, OSHA factored out of its analysis a number of elements considered in the cost chapter. OSHA does, however, provide alternate scenarios that factor in a few of these elements at the conclusion of this ETS, for comparison purposes. The following are the two most significant ways in which OSHA's main analysis has likely undercounted the number of hospitalizations and fatalities prevented by the ETS: (1) it does not account for older workers (ages 65 to 74), even though it included workers over age 64 in its cost analysis; and (2) it excluded all federal contractors and healthcare workers (covered under 29 CFR 1910.502),[3] even though they also are included in the cost analysis.

First, while the cost section accounts for direct employer costs for all workers impacted by the ETS, OSHA factors out of its Health Impacts analysis the impacts for workers over the age of 64. Including these higher age cohorts would introduce the possibility of overestimating the share of COVID-19 hospitalizations and fatalities among workers. In these older cohorts, the employment-to-population ratio falls rapidly with age, while fatalities related to COVID–19 increase rapidly with age. In other words, the people in the workforce in this age group tend to be closer to 65 years old while the fatalities related to COVID-19 are higher for people over 70 where there are fewer people in the workforce.

Second, OSHA has removed from its health impacts a large number of workers that it had included in its cost analysis. To ensure OSHA's accounting of the scope exemptions to the ETS resulted in a *cost estimate* which has a tendency toward the upper bound, OSHA: (1) assumed, for the purpose of the cost analysis, that employers and employees covered by the Safer Federal Workforce Task Force COVID-19 Workplace Safety: Guidance for Federal Contractors and Subcontractors will also have contracts to perform work in workplaces where they are not covered under that Guidance (i.e., where the employer contracts with an entity other than the federal government and so would be covered by this ETS); and (2) fully integrated employees currently covered by the Healthcare ETS into this ETS's scope, based on the assumption, again solely for the purpose of costing, that employees currently covered only by the Healthcare ETS will be subject to the requirements of this ETS for approximately 4 months (4 months of the 6 month estimated lifespan of this ETS). These assumptions, while justifiable for costing, would result in a bias toward higher impacts if OSHA incorporated them into this analysis. Therefore, OSHA excluded those workers from its main health impacts estimate.

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[3] This also effectively excludes workers who may be vaccinated under the vaccination rule CMS is currently promulgating.

B. Data, Assumptions and Data Estimation Methods of the Analysis

Throughout its analysis, OSHA adopts various simplifying assumptions. OSHA's key assumptions are summarized below and discussed later in the analysis:

- There will be only 6 months of health impacts accruing from vaccinations received while the ETS is in effect (see explanation below), although the positive health impacts of vaccination will extend beyond 6 months.
- Employed workers analyzed are ages 18–64. In its alternative scenario, OSHA also analyzed adding workers ages 65-74 (a combined 18-74).
- Employed and unemployed have the same risk of becoming a COVID-19 case (infected), a hospitalized case, or a fatality.[4]
- Employed and unemployed have the same vaccination rate (pre-ETS).
- OSHA assumes the risk of cases/fatalities for unvaccinated workers declines to the level for vaccinated workers by virtue of vaccination.
- Over a 6-month period, the continuing average baseline number of worker infections and fatalities will remain constant.

Assumption that the infection and fatality rates will remain constant

In determining the number of worker infections and fatalities averted absent this ETS, OSHA uses infections and fatalities occurring between April 1, 2021 and August 31, 2021 to generate infection and fatality rates. These rates are then applied to the number of employees who will be vaccinated under the ETS for health impacts analysis purposes to estimate cases and fatalities that are averted in employees, ages 18-64, vaccinated because of the ETS over 6 months. OSHA assumes therefore that the infection and fatality rates it generated will remain constant over the 6 months for which impacts are taken. While this simplifying assumption does not take into account the cyclical nature of the course of the pandemic, it provides a transparent estimate of averted fatalities and hospitalizations without the use of a projection (see discussion below) that requires several underlying assumptions regarding the size of the susceptible population, the reproduction number of the virus, the rise of new variants, and other mitigation measures. In lieu of a more complicated baseline projection, OSHA uses alternative scenarios. For example, as a secondary scenario, health impacts are calculated using baseline data from 19 months of the pandemic (from March 1, 2020 to September 30, 2021).

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[4] This assumption helps to ensure a lower bound health impacts estimate because the unemployed include those individuals who are not seeking employment and therefore theoretically have less risk of infection, hospitalization, and death than the employed, many of whom, as part of their jobs, will, of necessity, have contact with a larger number of potentially infected people and typical characteristics of workplaces are especially likely to facilitate transmission of the virus (see footnote 15). Thus, OSHA believes that assuming the unemployed and employed have the same risk results in a lower bound estimated infection rate, which in turn, results in a lower bound estimate of hospitalizations and deaths.

As it did for its Healthcare ETS (86 FR at 32537), OSHA considered the alternative of using available forecasting models of cases and fatalities that attempt to consider the potential influence of these types of factors on the pandemic. However, as OSHA noted in that ETS, a review of forecasting models available to the public over the past year shows that they are typically short-range models not designed to accurately forecast out beyond several weeks. The uncertainty of the projections of the trajectory of the pandemic that these models provide increases the farther out in time they go.[5] OSHA has found none are sufficiently reliable to support an estimate of COVID–19 cases and fatalities for the next 6 months. Given that degree of uncertainty, OSHA's estimates of health impacts from the ETS are, therefore, derived from its own analysis of the cases in the previous 6-month period, with subsequent adjustments as described below.

In conclusion, the simplifying assumptions provided above mean that specific analytical inputs and outputs might be overestimated or underestimated to the extent that real world conditions vary from these assumptions. As discussed further, other scenarios exploring some alternative simplifying assumptions are presented at the end of this document.

C. Limitations of the Analysis

OSHA was not able to adjust its quantitative estimates to account for several factors that might alter the potential health impacts of the ETS. These include:

- Unreported infections or fatalities.
- Potential reductions in fatalities from improvements in medical treatment for COVID–19 in the coming months.
- Impacts of variations in the SARS–CoV-2 virus on disease transmissibility or severity, virus susceptibility to one or more class of therapies, and neutralization of antibodies generated during previous infection or vaccination.
- Changes in social and state, local, tribal, and territorial government practices and restrictions beyond those reflected in the data on which OSHA relies. These changes could result in either more or fewer vulnerable workers exposed to COVID–19.
- Changes in telework and in-person work status, which would have an effect on hospitalizations and fatalities among unvaccinated workers.
- Chronic long-term impacts of COVID–19 disease, including any potential risk of premature death.

In addition, estimating baseline COVID–19 infections and fatalities that will occur in the absence of the ETS is uncertain due to several factors, including: (1) the novel nature of the virus and resulting pandemic; (2) heterogeneous timing and conditions of exposure control policies

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[5] For example, the CDC ensemble forecasts predicts cases, fatalities and hospitalizations out by 4 weeks.

enacted by various governmental authorities; (3) new virus variants; and (4) the effect of currently or newly authorized vaccines.

While OSHA relied on the best available evidence in forming its estimates, it is possible that given these analytical limitations, aspects of OSHA's quantitative estimate of health impacts either may be over- or under-estimated. Additionally, a number of other positive health impacts were not quantified, as discussed above.

OSHA requests public comments on relevant data, literature, and methodological suggestions that it might use to improve underlying assumptions or otherwise address these limitations at the final standard rule stage. OSHA also welcomes comments on all aspects of the health impacts analysis.

D. Health Impacts Analysis

OSHA now presents its Health Impacts analysis in a series of steps so that its calculation methodology is readily apparent. OSHA notes that it pulled the calculations it presents here from the spreadsheets supporting those calculations (**See OSHA, October 28, 2021**). Therefore, some minor differences may appear in the calculations due to rounding. In all cases, the spreadsheet numbers are the correct final numbers.

Step 1: Estimate the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes.

The first step in estimating the expected number of COVID–19 infections, hospitalizations, and fatalities averted due to employee (ages 18 to 64) vaccinations under this ETS is to estimate the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes.

OSHA relied on the Cost Analysis Profile as starting point. In the Costs section, OSHA estimates that 20,822,580 employees will likely be vaccinated as a result of this ETS.[6] In this Health Impacts analysis, however, OSHA is reducing its estimate of the number of vaccinated employees to ensure that the Health Impacts analysis is biased toward the lower bound (not over counting any hospitalizations or fatalities prevented by this ETS). Ultimately, based on the calculations in this step, OSHA reduces the number of employees likely to be vaccinated under the ETS from 20,822,580 (Cost number) to 18,914,528 (Impacts number). The calculations are explained below.

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[6] Outside of any employees subject to the Healthcare ETS who become vaccinated under this ETS, under the assumption, for cost purposes, that the Healthcare ETS terminates two months after this ETS's effective date (see discussion in text about how OSHA calculated estimates for employees subject to the Healthcare ETS separately for cost reasons).

Reduction from 20,822,580 vaccinations to 18,914,528[7]

    a. *Data points*

        i. Baseline number of employees: 84,194,885 employees covered by the ETS (see Table 5 in the Industry Profile).

        ii. Baseline number with healthcare workers removed: 74,257,625 covered by this ETS [removed all 9,937,260 employees covered by the Healthcare ETS (§ 1910.502) (from the Industry Profile, as discussed in the main analysis for this ETS)]

    b. *Calculate percentage decrease for federal contractors.* OSHA removed all employees covered by the Contractor Guidance (i.e., all federal contractors) from the Impacts analysis. In developing this estimate, OSHA relied on the estimated 1.76 million employees who work on a federal contract; this estimate is from the 2021 Department of Labor Wage and Hour Division (WHD) Notice of Proposed Rulemaking (NPRM), "Increasing the Minimum Wage for Federal Contractors," 86 FR 38816, 38864 (July 22, 2021).[8] OSHA then assumed, based on the Profile, that about two-thirds of these 1.76 million workers (1,230,699 employees) are at firms with 100 or more employees. This 1,230,699 is 1.66 percent of the profile labor force of 74,257,625 (see data point in a.).[9] This 1.66 percent is used to adjust downward the number of employees covered under the ETS in the spreadsheets supporting this analysis, which ultimately reduces the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes.

    c. *Calculate percentage decrease for workers in the age group 65-74.* OSHA calculated the percentage decrease for vaccinated workers between ages 65-74 in a similar manner. The BLS Current Population Survey (CPS) identified 7,971,000 workers in that age cohort (CPS, January 22, 2021). Assuming that about two-thirds work at firms with 100 or more employees (again based on the Profile Spreadsheet and CPS), OSHA found that 7.63 percent of the profile were workers 65-74 (again compared to the 74,257,625 in data point a). This 7.63 percent (like the 1.66 percent of Federal contractor workers described above) is used to adjust downward the number of employees covered under the ETS in the spreadsheets supporting this analysis, which,

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[7] This is approximately 72.5 percent of the number of currently unvaccinated workers (approximately 26 million) covered by this ETS for Health Impacts purposes (see Health Impacts spreadsheet, OSHA, October 28, 2021).

[8] In the NPRM, WHD states that "[t]here are no Government data on the number of employees working on Federal contracts," but develops an estimate (86 FR at 38859-38865), which OSHA concludes is the best available evidence of the number of employees covered by the Contractor Guidance.

[9] Deducting the full 1,230,699 employees likely results in an impacts estimate at the lower bound, and thus an underestimate of benefits, because it is highly likely that some employees subject to the Healthcare ETS and employees over the age of 64 are also covered by the Contractor Guidance. Each of these employees is therefore likely deducted from the Profile two, or even three, times.

again, ultimately reduces the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes.

OSHA applies the percentage reductions in the total number of employees to the number of employees it estimates will be vaccinated. 100% minus 1.66% is 98.34%. 100% minus 7.63% is 92.37%. Another way to understand this analysis is to combine the two percentages above (98.34% and 92.37%) into a single percentage (90.83%, or .9083, the product of the two percentages)[10] for the following equation 20,822,580 (from Cost) – (20,822,580 x .9083) = 18,914,528 employees who will be vaccinated under the ETS for Health Impacts analysis purposes.

OSHA determined that it is not necessary to adjust this number downward to account for employees subject to the Healthcare ETS, 29 CFR 1910.502, because OSHA calculated estimates for these employees separately for cost reasons (OSHA, 2021), and this analysis is relying on the analyses generated for cost purposes. The unadjusted number of employees who will be vaccinated under the ETS in the relevant analysis did not take these employees into account. The derivation of all these calculations, while not discussed in more detail in this analysis, is contained fully in the Analytical Spreadsheets Supporting the Health Impacts of the COVID-19 Vaccination and Testing ETS, (OSHA, October 28, 2021).

Step 2: Estimate baseline unvaccinated cases and fatalities over 6 months, ages 18-64

For the second step, OSHA must estimate the baseline unvaccinated cases and fatalities over 6 months, ages 18-64. To derive those estimates, OSHA must first derive the unvaccinated infection and fatality rates over 6 months for ages 18-64 and then apply those infection and fatality rates to the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes (from Step 1, 18,914,528). This step's goal, therefore, is to derive estimates of cases and fatalities for these covered employees under the assumption that the ETS was never promulgated and these employees were never vaccinated.

To derive the unvaccinated infection and fatality rates, OSHA relied on recently-published CDC data from the following jurisdictions around the country, representing 30 percent of the total U.S. population: 14 states (Alabama, Arizona, Arkansas, Colorado, Florida, Georgia, Idaho, Louisiana, Massachusetts, Michigan, Nebraska, New Mexico, Utah, and Wisconsin); one large metropolitan city (New York City); and one large county that includes a large metropolitan city (King County, 2021) (CDC, Rates by Vaccine Status, 2021).[11] OSHA uses these data to derive its estimates because they are the best available data for establishing the unvaccinated infection and fatality rates for the time period in this analysis. First, the data shows weekly cases and fatalities between April 1, 2021 and August 31, 2021, 5 months of recent data, which is both a robust pool of data and indicative of recent trends in cases and fatalities. Second, the data are broken down by vaccinated and unvaccinated persons, which permits OSHA to calculate counts

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[10] This percentage is correct; it is a rounded number combining two percentages that actually extend beyond 2 decimal points (0.90836658).

[11] Weekly cases are reported by all 16 jurisdictions, and weekly fatalities are reported by 15 of 16 jurisdictions.

of unvaccinated cases and fatalities. Third, and finally, the data are broken down by age group (18-29, 30-49, 50-64), which permits OSHA to calculate counts of the relevant age range for this Health Impacts analysis.

It is true that these data do not include data collected from the entire country. OSHA made an adjustment to account for this partial coverage by using the CDC's national COVID-19 Cases and Deaths by State over Time (CDC, October 28, 2021) and separate Seattle/King County (Washington) data.[12] This dataset contains daily counts (not broken out by vaccination status) of cases and fatalities for all states from the beginning of the pandemic in January 2020 until the present. After using this dataset to calculate the case and fatality rates for the week of April 4, 2021 thru the week of August 29, 2021, both for the country and then for the more limited coverage of the jurisdictions listed above,[13] OSHA used the ratio of the limited jurisdiction rate to national rate as an adjustment factor.[14] OSHA found that the case rate in the full U.S. was roughly 81 percent of the case rate in the selected states (2,812.51 cases per 100,000 in the full U.S. and 3,474.50 cases per 100,000 in the selected states), and that the fatality rate in the full U.S. was roughly 69 percent of the fatality rate in the selected states (27.75 fatalities per 100,000 in the full U.S. and 40.39 fatalities per 100,000 in the selected states). OSHA will account for this difference (i.e., OSHA will make a "geographic adjustment downward") later in this analysis.

It is also true that these data include infections and fatalities that are both work-related and community acquired. In other words, these data do not take into account that only some cases, fatalities, and hospitalizations likely result from workplace exposures and others may result from community exposures (i.e., they are not work-related). OSHA adjusts for this, later in the analysis, by reducing downward by 20 percent the number of cases, fatalities, and hospitalizations averted due to vaccinations received under the ETS. This 20 percent reduction is similar to the reduction OSHA took in the Healthcare ETS to account for community-acquired infections (86 FR at 32542).[15] OSHA presents in Section E an alternative scenario in which

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[12] This state dataset also includes New York City. For Seattle/King County (Washington), the agency accessed case and fatality data (King County, 2021).

[13] Since this dataset contains counts only, to derive rates, OSHA used population numbers from the 2020 US Census, Table 2, (Census Bureau, April 26, 2021).

[14] This methodology assumes that the share of the population vaccinated for the limited group is similar to the national share.

[15] The 20% reduction is based on the manner in which the virus is transmitted and the high incidence of workplace infection documented in *Grave Danger*, Section III.A. of the preamble to this rule. As noted there, workers covered by this rule are likely to spend far more time at work than anywhere else but their homes. Typical characteristics of workplaces are especially likely to facilitate transmission of the virus. Workers are indoors, in proximity to multiple other people for prolonged periods, without control of their environment or those they interact with, in spaces not originally designed for physical distancing and often with poor ventilation. The Grave Danger section of the preamble describes numerous outbreaks that have occurred as a result of workplace transmission, as well as research papers evaluating COVID-19 in workers and workplaces. In addition, a study of the Nashville Metro Health Department (Nashville, November 20, 2020) found 200 COVID-19 clusters occurring in 18 settings, 16 of which were workplace settings. A study by Allan-Blitz et al. (Allan-Blitz et al., December 11, 2020) found 149,957 cases in Los Angeles associated with an occupation. Fisher et al (Nov. 6, 2020) found that non-teleworking employees had a 50% higher infection rate than teleworkers. That finding is likely an underestimate of the elevated risk faced by

community spread is estimated at 50%. That analysis shows that the fatalities and hospitalizations prevented by the rule remain very substantial under that scenario.

OSHA notes that it considered using other data to derive the unvaccinated infection and fatality rates. However, OSHA determined that these other data were not the best available evidence for making this derivation. Specifically, OSHA considered relying on the number of "confirmed" (by lab test) COVID-19 infections from the Centers for Disease Control and Prevention (CDC), specifically, the CDC's Cases and Deaths, Daily and Total Trends, found on the CDC COVID Data Tracker website (CDC Data Tracker) (CDC, September 30, 2021). This dataset has daily counts of cases and fatalities for the US for the entire pandemic (from January 2020 to the present). Its main limitation is the data does not differentiate between vaccinated and unvaccinated persons, while, as stated, OSHA is applying these rates only to unvaccinated persons.

Despite the shortcomings of this data source for the main scenario, its collection of data from the beginning of the pandemic provides support for the method used in its main analysis. Additionally, OSHA utilizes 19 months of the pandemic (from March 1, 2020 to September 30, 2021) as the basis for an alternate scenario at the end of this document. While these data span the full course of the pandemic for all jurisdictions, they may bias impacts in a downward direction for the unvaccinated under current conditions.

Step 2A: Estimate the baseline unvaccinated cases over 6 months, ages 18-64.

To estimate the baseline unvaccinated cases over 6 months, ages 18-64, OSHA first estimated that the weighted average number of weekly cases per 100,000 unvaccinated people, ages 18-64, is 307.26 cases, using the weekly unvaccinated case data in CDC, Rates by Vaccine Status, 2021 and 2019 population data by age.[16] This was done by multiplying each age case rate per 100,000 by their population share, then dividing by the total population age 18-64. OSHA then multiplied this weighted average by the number of weeks over the six months (26) and divided that number by 100,000 to estimate the 6-month unvaccinated infection rate for ages 18-64 of 7.99 percent. Finally, OSHA applied that infection rate to the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes (from Step 1) to derive the baseline unvaccinated cases over 6 months, ages 18-64 (18,914,528 x .0799 = 1,511,026 cases).

Step 2B: Estimate the baseline unvaccinated fatalities over 6 months, ages 18-64.

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workers in physical workplaces as a result of their work, because the study defined teleworkers to include anyone who teleworked part of the time, with the result that some of the infections attributed to teleworkers may have resulted from transmission in the physical workplace. Marshall et al., (Marshall et al., 2020) found half of the exposure by individuals to COVID-19 occurred in a workplace setting. Another study found elevated mortality risks for in-person workers (Hawkins, Jan.10,2021).

[16] The population numbers are from the US Census, Annual Estimates of the Resident Population for Selected Age Groups by Sex for the United States: April 1, 2010 to July 1, 2019 (NC-EST2019-AGESEX) (Census Bureau, October 8, 2021c)).

To estimate the baseline unvaccinated fatalities over 6 months, ages 18-64, OSHA first estimated the weighted average number of weekly fatalities per 100,000 unvaccinated people, ages 18-64, is 2.64 fatalities, using the weekly unvaccinated fatality data in CDC, Rates by Vaccine Status, 2021 and 2019 population data. This was done by multiplying each age fatality rate per 100,000 by their population share, then dividing by the total population age 18-64. OSHA then multiplied this weighted average by the number of weeks (26) and divided that number by 100,000 to obtain the 6-month unvaccinated fatality rate for ages 18-64 of .0685 percent. . Finally, OSHA applied that fatality rate to the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes (from Step 1) to derive the baseline unvaccinated fatalities over 6 months, ages 18-64 (18,914,528 x .000685 = 12,961 fatalities).

Step 3: Estimate cases and fatalities that are averted in employees vaccinated because of the ETS, ages 18-64, over 6 months

For the third step, OSHA estimates the number of cases and fatalities averted in employees vaccinated because of the ETS, ages 18-64, over 6 months. OSHA first derives the vaccinated infection and fatality rates over 6 months for ages 18-64 and then applies those infection and fatality rates to the number of employees who will be vaccinated under the ETS (from Step 1, 18,914,528) to estimate the baseline vaccinated cases and fatalities over 6 months, ages 18-64 (i.e., the breakthrough cases and fatalities). OSHA then subtracts the baseline vaccinated cases over 6 months, ages 18-64 (i.e., the breakthrough cases) from the baseline unvaccinated cases over 6 months, ages 18-64 (1,511,026 cases, from Step 2, above), and similarly for fatalities, OSHA subtracts the baseline vaccinated fatalities over 6 months, ages 18-64 (i.e., the breakthrough fatalities) from the baseline unvaccinated fatalities over 6 months, ages 18-64 (12,961 fatalities, from Step 2, above), to derive the number of cases and fatalities averted in employees vaccinated because of the ETS, ages 18-64, over 6 months. Finally, OSHA adjusts these numbers downward to account for "geographical adjustment" and community acquired infections (as discussed above).

Step 3A: Estimate cases that are averted in employees vaccinated because of the ETS, ages 18-64, over 6 months

Estimate the baseline vaccinated cases over 6 months, ages 18-64. OSHA estimated that the weighted average number of weekly cases per 100,000 vaccinated people, ages 18-64, is 46.63 cases, using the weekly unvaccinated case data in CDC, Rates by Vaccine Status, 2021 and 2019 population data. OSHA then multiplied this weighted average by the number of weeks for the 6 months (26) and divided that number by 100,000 to obtain the 6-month vaccinated infection rate for ages 18-64 of 1.21 percent. OSHA applied that infection rate to the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes (from Step 1) to derive the baseline vaccinated cases over 6 months, ages 18-64 (18,914,528 x 0.0121 = 229,339 cases).

Derive adjusted cases. To derive the number of adjusted cases averted in employees vaccinated because of the ETS, ages 18-64, over 6 months, OSHA subtracts the baseline vaccinated cases over 6 months, ages 18-64 (229,339, the breakthrough cases) from the baseline unvaccinated

cases over 6 months, ages 18-64 (1,511,026 cases, from Step 2, above), and then multiplies that number by 80 percent to adjust for community acquired infections and then by 81 percent to adjust for the geographic adjustment.

((1,511,026 - 229,339) x .80 x .81 = 830,533 cases averted in employees vaccinated because of the ETS, ages 18-64, over 6 months)

Step 3B: Estimate fatalities that are averted in employees vaccinated because of the ETS, ages 18-64, over 6 months

Estimate the baseline vaccinated fatalities over 6 months, ages 18-64. To estimate the baseline vaccinated fatalities over 6 months, ages 18-64, OSHA first estimated that the weighted average number of weekly fatalities per 100,000 vaccinated people, ages 18-64, is 0.12 fatalities, using the weekly vaccinated fatality data in CDC, Rates by Vaccine Status, 2021 and 2019 population data. OSHA then multiplied this weighted average by the number of weeks of the 6 months (52/2 = 26) and divided that number by 100,000 to obtain the 6-month vaccinated fatality rate for ages 18-64 of .00311 percent. OSHA applied that fatality rate to the number of employees who will be vaccinated under the ETS for Health Impacts analysis purposes (from Step 1) to derive the baseline vaccinated fatalities over 6 months, ages 18-64 (18,914,528 x .0000311 = 589 fatalities).

Derive adjusted fatalities. To derive the number of adjusted fatalities averted in employees vaccinated because of the ETS, ages 18-64, over 6 months, OSHA subtracts the baseline vaccinated fatalities over 6 months, ages 18-64 (589, the breakthrough fatalities) from the baseline unvaccinated fatalities over 6 months, ages 18-64 (12,961 fatalities, from Step 2, above), and then multiplies that number by 80 percent to adjust for community acquired infections and then by 69 percent to adjust for the geographic adjustment.

((12,961 - 589) x .80 x .69 = 6,830 fatalities averted in employees vaccinated because of the ETS, ages 18-64, over 6 months)

Explanation of 6 month period for health impacts

OSHA has determined that it is appropriate to rely on 6 months of health impacts in connection with vaccinations received by employees under the ETS. Section 6(c) of the OSH Act, provides that an ETS "shall be effective until superseded" by a permanent standard promulgated under section 6(b) of the Act, and that OSHA shall promulgate such a permanent standard "no later than six months after publication" of the ETS.

Under section 6(c), OSHA considers the adverse health consequences that will be prevented by virtue of an ETS that remains in effect for six months. These consequences may manifest immediately, as in the case of some hazards, or after a substantial latency period, as is the case with asbestos and lung cancer, but in either case the agency considers only the consequences that accrue from the issuance of an ETS that lasts six months. *Asbestos Information Ass'n/North*

America v. OSHA, 727 F.2d 415 (5th Cir.1984). Because the statute presumes that an ETS will be superseded by a permanent standard after six months, the health consequences that will come about as a result of the permanent standard are properly attributed to it rather than the ETS. Accordingly, in this case, the agency's primary analysis considers that the issuance of an ETS will avert six months of deaths and hospitalizations.

The agency also considered an analysis that relies on only four months of averted health consequences and shows that the deaths and hospitalizations prevented remain very substantial. The idea behind this approach is that it might take two months from the effective date of the ETS for employees to become fully vaccinated, and at that point only four months remain until the assumed replacement of the ETS by a permanent standard. However, the agency does not agree that this is the correct way of applying the statute. The vaccinations employees receive during the six month ETS will continue to protect them after the expiration of the ETS. Under section 6(c), the question is how many deaths or illnesses a six month ETS will prevent, compared with the situation in which the agency does not issue an ETS and instead issues a proposal and a final standard with similar protections six months later. These are the lives that are saved because of the ETS, or put another way, the lives that would be lost but for the ETS. If there is a lag between the ETS' effective date and full vaccination, that same lag period would occur absent an ETS following issuance of a final standard. Regardless of the existence or duration of a lag, the ETS prevents six months of deaths and hospitalizations. In any event, the agency presents an alternative scenario at the end of this analysis that relies on four months of averted health consequences rather than six months. As with the other alternative analyses conducted in this section, OSHA finds that, regardless of the analytical approach taken, the health consequences of the ETS remain very substantial and fully justify the issuance of the ETS.

Note on vaccine effectiveness

OSHA notes that the effectiveness of vaccination is accounted for in data above because the data account for breakthrough cases and fatalities in vaccinated employees. Thus, OSHA need not make further downward adjustments to account for vaccine effectiveness.

OSHA notes that its methodology for determining vaccine ineffectiveness differs from the methodology used in the Healthcare ETS. OSHA has a legal duty to weigh the evidence before it. Since the CDC Rates and Rate Ratio Data only become available recently (in mid-October), OSHA methodology in the Healthcare ETS is simply not comparable to OSHA's methodology here.[17]

Step 4: Estimate hospitalizations that are averted in employees vaccinated because of the ETS, ages 18-64, over 6 months

OSHA uses the hospitalization rate for the working population to derive the number of hospitalizations averted in 6 months due to vaccination. The hospitalization rate is defined as the number of hospitalizations among the working population due to COVID-19 reduced by the total

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[17] In this ETS, OSHA addressed the effect of teleworking in the industry profile, and it is therefore not necessary to do so again here. (For comparison, see Healthcare ETS, 86 FR at 32485).

number of such hospitalizations that end in death. In other words, this estimate removes the hospitalizations that ultimately result in death to focus only on those that do not. In this case, OSHA uses the proportion of fatalities among COVID-19 associated hospitalizations of 18 to 49 year olds, combined with the fatality derivation above, to determine the count of hospitalizations among all workers. Using this age range will result in an undercount of hospitalizations prevented.[18] From March 1, 2020 through August 31, 2021, 2.4 percent of COVID-19 associated hospitalizations resulted in in-hospital death and this factor is used as the baseline estimate of the hospitalization rate [COVID-NET: COVID-19-Associated Hospitalization Surveillance Network, Centers for Disease Control and Prevention. WEBSITE. Accessed on October 4, 2021].

Estimate hospitalizations averted in 6 months due to vaccination.

  a. Data Point. Proportion of COVID-19 associated hospitalizations of 18 to 49 year olds that ended in fatalities from March 1, 2020 through August 31, 2021:
  2.4 percent or 0.024.
  [COVID-NET: COVID-19-Associated Hospitalization Surveillance Network, Centers for Disease Control and Prevention. WEBSITE. Accessed on October 4, 2021]

  b. Assuming that the number of COVID-19 associated fatalities in hospitals is 2.4 percent of the number of COVID-19 associated hospitalizations, divide number of fatalities averted in employees vaccinated because of the ETS, ages 18-64, over 6 months by .024 to determine number of hospitalizations averted in 6 months due to vaccination, including hospitalizations that ended in fatalities:
  6,830/0.024 = 284,565

  c. Factor out hospitalizations that ended in fatalities to determine hospitalizations that are averted in employees vaccinated because of the ETS, ages 18-64, over 6 months. Subtract number of fatalities averted in employees vaccinated because of the ETS, ages 18-64, over 6 months:
  284,565– 6,830 =277,736

OSHA notes that because it derives the number of hospitalizations averted in 6 months due to vaccination from the number of fatalities averted in 6 months due to vaccination and that estimate accounted for community acquired infections and the geographical adjustment, the number of hospitalizations averted in 6 months due to vaccination also reflects these adjustments.

Alternate Scenarios and Ancillary Health Impacts

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[18] These data only reported two age ranges, a lower age range (18-49), which had a relatively low death-hospitalization rate, and a higher age range (50 up), which had a very high death-hospitalization rate. To be consistent with biasing the estimates toward the lower bound, OSHA uses the lower age range only.

Table 2, below, shows the main estimate (explained in Section D, above) and the ancillary health impacts that OSHA quantified.

Table 2. Main Estimate of Hospitalizations and Fatalities Averted and Quantified Ancillary Impacts.

Scenario	Hospitalizations	Fatalities
Main Estimate (Age 18-64)	277,736	6,830
Ancillary Community Health Impacts	69,434	1,707
TOTAL Estimate (Age 18-64) with Ancillary Community Health Impacts	347,170	8,537

In the main estimate, OSHA reduced downward the number of fatalities and hospitalizations by 20 percent to account for community acquired infections. In the Table 2 total, OSHA shows fatalities and hospitalizations without the reduction. A worker who is vaccinated under the ETS will be protected at both work and elsewhere (e.g., church, shopping malls).

Table 3, below shows the six alternative estimates OSHA developed.

Table 3 and Alternative Scenarios (for Comparison Purposes)

Alternative Scenarios	Hospitalizations	Fatalities
A. **Use Age 18-74**	563,102	13,847
B. **Add employees subject to CFR1910.502 (Healthcare ETS)**	306,063	7,526
C. **Use 19-Month Baseline**	144,720	3,559
D. **50 Percent Community Acquired Infections**	173,585	4,268
E. **Four Months of Impacts**	185,157	4,553
F. **Infection-Induced Immunity**	255,548	6,284

For the first alternative scenario (A), OSHA added fatalities and hospitalizations for workers ages 65-74 to the main estimate (in Table 2). Although these workers are covered by the ETS and taken into account for cost purposes, adding their fatalities and hospitalizations into the health impacts introduces the possibility of overestimating the share of COVID-19 hospitalizations and fatalities among workers for reasons stated in the Introduction to this Health Impacts analysis.

For the second alternative scenario (B), OSHA added fatalities and hospitalizations for workers currently covered under the Healthcare ETS (1910.502) to the main estimate (in Table 2). Although these workers are covered by the ETS and taken into account for cost purposes, OSHA integrated employees currently covered by the Healthcare ETS into scope, based on the assumption, solely for the purpose of costing, that employees currently covered only by the Healthcare ETS will be subject to the requirements of this ETS for approximately 4 months (4 months of the 6 month estimated lifespan of this ETS). This assumption, while appropriate for costing, would have resulted in a bias toward higher impacts if OSHA had incorporated these workers into its main health impacts estimate. It should be noted that the estimates in this alternative scenario are likely overstated significantly, as OSHA's alternative scenario does not take into account the impact of the forthcoming CMS rule mandating vaccination on many of the workers in this pool. Thus, the impacts associated with this alternative scenario are likely much closer to those presented in the main estimate.

For the third alternative scenario (C), OSHA relies on the number of "confirmed" (by lab test) COVID-19 infections from the Centers for Disease Control and Prevention (CDC), specifically, the CDC's Cases and Deaths, Daily and Total Trends, found on the CDC COVID Data Tracker website (CDC Cases) (CDC, September 30, 2021) as the basis for this alternate scenario utilizing 19 months of the pandemic (from March 1, 2020 to September 30, 2021) as a baseline. While these data span the full course of the pandemic for all jurisdictions, they may bias impacts in a downward direction for the unvaccinated under current conditions. Unlike the other alternate scenarios described here, this scenario uses a different methodology to derive its estimates of hospitalizations and fatalities. An overview of this methodology is discussed in the Health Impacts 19-Month Alternate Scenario of the COVID-19 Vaccination and Testing ETS (OSHA, October 29, 2021).

For the fourth alternative scenario (D), OSHA reduced downward the number of fatalities and hospitalizations by 50 percent to account for community acquired infections (rather than 20 percent). Thus, this scenario estimates fewer hospitalizations and fatalities averted because of the ETS, although the ancillary community health impacts are higher. Notwithstanding this alternate scenario, for the reasons stated in Section D of this analysis, OSHA concluded that a 20 percent reduction for community-acquired infections is reasonable.

For the fifth alternative scenario (E), OSHA relies on 4 months of impacts (i.e., positive health impacts that accrue from the beginning of the third month to the end of the sixth month after the ETS goes into effect) instead of 6 months. This results in a lower, but still substantial, estimate of hospitalizations and fatalities prevented.

For the sixth alternative scenario (F), OSHA reduces the number of fatalities and hospitalizations to account for the effects of infection-induced immunity. However, OSHA believes any such effects are uncertain. OSHA found that workers who were previously infected with SARS-CoV-2 and are not yet fully vaccinated are at grave danger from SARS-CoV-2 exposure. Although some workers who had COVID-19 may have significant protection from subsequent infections, the level of protection likely varies greatly and some individuals may have no protection at all. Furthermore, the level of protection, if any, provided by a given person's SARS-CoV-2 infection cannot be ascertained based on currently-available testing methods. Therefore, OSHA

determined that it is necessary to protect all workers who had a prior COVID-19 infection through the requirements of the ETS. If all unvaccinated employees who were a case in the past 6 months were removed from health impacts, there would be approximately 546 fewer fatalities prevented (see Health Impacts spreadsheet for calculation derivation, OSHA, October 28, 2021).

F. CONCLUSION

In this analysis, OSHA examined the potential of the ETS to prevent hospitalizations and fatalities from COVID–19 among workers in the U.S. OSHA estimated the number of hospitalizations and fatalities in the absence of an ETS using historical monthly data on infections and fatalities during the pandemic.

The health impacts of the ETS reflect the reduction in hospitalizations and fatalities with an average vaccination rate of approximately 72.5 percent for currently unvaccinated workers. Averted hospitalizations and fatalities, based on the primary estimate, are 277,736 and 6,830, respectively.

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